

Claims

What we claim is:

5 [0022] 1. A micro-valve, comprising:

a fluid guiding structure containing a fluid inlet port and a fluid outlet port;

a fluid communication channel, formed within said fluid guiding structure,

fluidically coupling said fluid inlet port to said fluid outlet port;

an intermediary port, formed within said fluid communication channel, said fluid

10 inlet port being fluidically coupled to said fluid outlet port valve through
said intermediary port;

a cantilever element, moveably positioned proximate to said intermediary port
within said fluid communication channel;

an energy conversion body defining a chamber enclosing a working fluid, said

15 energy conversion body being at least partially formed of a semiconductor
material, said energy conversion body including a flexible membrane
mechanically coupled to said cantilever element through a first pedestal;
and

a stiffening means positioned on said flexible membrane proximate to said first

20 pedestal and said fluid inlet port.

[0023] 2. The micro-valve of claim 1 wherein said cantilever element includes a set of
beams operative as a restoring force during deflection of said valve

element by said flexible membrane.

[0024] 3. The micro-valve of claim 1 wherein said flexible membrane is single crystal silicon between 15 and 100 microns thick.

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[0025] 4. The micro-valve of claim 1 wherein said stiffening means is one or more pedestals.

[0026] 5. The micro-valve of claim 1 wherein said stiffening means is one or more regions of increased thickness of said flexible membrane.

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[0027] 6. A micro-valve, comprising: an actuation means attached to a flexible membrane;

said flexible membrane attached to a cantilever element through at least one

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pedestal;

said cantilever element normally closed over an inlet port;

said inlet port in fluid communication with at least one outlet port; and

a stiffening means positioned on said flexible membrane proximate to said at least one pedestal and said fluid inlet port.

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[0028] 7. The micro-valve of claim 6 wherein said cantilever element includes a set of beams operative as a restoring force during deflection of said valve element by said flexible membrane.

[0029] 8. The micro-valve of claim 6 wherein said flexible membrane is single crystal silicon between 15 and 100 microns thick.

5 [0030] 9. The micro-valve of claim 6 wherein said stiffening means is one or more pedestals.

[0031] 10. The micro-valve of claim 6 wherein said stiffening means is one or more regions of increased thickness of said flexible membrane.

10 [0032] 11. The micro-valve of claim 6 wherein said actuation means can extend said flexible membrane in a manner proportional to an amount of energy supplied to said actuation means.

15 [0033] 12. The micro-valve of claim 6 wherein said cantilever element contains a compliant element attached onto a portion covering said inlet port.

[0034] 13. The micro-valve of claim 12 wherein said compliant element is a PTFE-like material.

20 [0035] 14. A mass flow controller comprising:
one or more normally closed micro-valves with pedestal and stiffening means;
one or more normally open micro-valves;
one or more flow restrictors;

one or more micro-machined pressure sensors; and
one or more temperature sensors.

[0036] 15. A pressure controller comprising:

5 one or more normally closed micro-valves with pedestal and stiffening means;
one or more normally open micro-valves;
one or more flow restrictors;
one or more micro-machined pressure sensors; and
one or more temperature sensors.

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[0037] 16. A micro-valve, comprising:

an actuation means attached to a flexible membrane;
said flexible membrane attached to a cantilever element through first pedestal;
said cantilever element normally closed over an inlet port;
15 said inlet port in fluid communication with at least one outlet port; and
said cantilever element having a second pedestal proximate to said first pedestal,
wherein said second pedestal is not attached to said flexible membrane.